3 Rs Physics Problem (Answers)

(Updated Dec 19)

(8 Bit ASCII graphics use code page 437 or 850, Terminal Font)
Helmut DK2ZA @ DB0FOR.#BAY.DEU.EU posed this question..

Here is one problem from a German physics contest for 16 year olds:

You have three resistors R1 = 10 Ohm, R2 = 20 Ohm & R3 = 30 Ohm.

Each resistor can absorb at most 5 Watts. You have only one source of electrical power, the voltage of which can be adjusted to any necessary value.

How do the resistors have to be connected so that when voltage is applied the total absorbed power is a maximum? How many watts will that be?

Have fun & vy 73 de Helmut, DK2ZA

My answer..

There are 8 ways to configure the 3 Rs.. (2^3)

1/ All in series..

```
            As currents all the same, highest R dissapates 5W.
─10─20─30─  P30=5W, V30=¹5*30 = 12.25V which is 50% of all R.
            So across all Rs, Voltage = 2x12.25 = 25.5V &
            Total Power = 5+5 = 10W
```

2/ All in parallel..

```
──┬──┬──┐   As the voltage are all the same, lowest R has 5W.
 10 20 30   P10=5W, V10=¹5x10 = 7.07V, as other Rs are mutiples
──┴──┴──┘   their power is proportionally less.
            Total Power = 5+(5/2)+(5/3) = 9.166W
```

3/ Parallel + Series A)..

```
──┬──┐      Here the 2 series Rs = the parallel R, so that is 5W
 10  │      P30=5W. V=12.25V as in 1/.
  │ 30      Total Power = 5+5 = 10W
 20  │
──┴──┘
```

4/ Parallel + Series B)..

```
──┬──┐      Here the 2 series Rs = 4x the parallel R, so that is 5W
 20  │      P10=5W. V=7.07 as in 2/. Series Rs have 1/5 the power, so
  │ 10      Total Power = 5+(5/5) = 6.00W
 30  │
──┴──┘
```

5/ Parallel + Series C)..

```
──┬──┐      Here the 2 series Rs = 2x the parallel R, so that has 5W
 30  │      P20=5W. V=¹20*5 = 10V. Series Rs have 1/2 the power, so
  │ 20      Total Power = 5+2.5 = 7.5W
 10  │
──┴──┘
```

```
6/ Series + Parallel a)..
     It is not obvious which R will have the max power!
            Assume 10R has 5W, then I = ¹(5/10) = 0.707A,
──10─┬──┐   I in 20R = 0.707*(30/50) = 0.424A,
    20 30   So P20 =0.424*0.424*20= 3.6W,
─────┴──┘   I in 30R = 0.707*(20/50) = 0.283A,
            So P30 =0.283*0.283*30= 2.4W,
            Total Power = 5+3.6+2.4 = 11W

7/ Series + Parallel b)..
            Assume 20R has 5W, then I =¹(5/20)= 0.5A
──20─┬──┐   I in 10R = 0.5*(30/40) = 0.375A,
    30 10   So P20 =0.375*0.375*10= 1.4W,
─────┴──┘   I in 30R = 0.5*(10/40) = 0.125A,
            So P30 =0.125*0.125*30= 0.47W,
            Total Power = 5+1.4+0.47 = 6.87W

8/ Series + Parallel c)..
            Assume 30R has 5W, then I=¹(5/30)= 0.408A
──30─┬──┐   I in 10R = 0.408*(20/30) = 0.272A,
    10 20   So P10 =0.272*0.272*10= 0.74W
─────┴──┘   I in 20R = 0.408*(10/30) = 0.136A,
            So P20 =0.136*0.136*20= 0.37W
            Total Power = 5+0.74+0.37 = 6.11W
```

So the answer is configuration 6/ to give 11 Watts.

Here is another 3 Rs Question that you can do in yor head.

What does this measure?

```
──┬───┬───┐
  25  50  75
──┴───┴───┘
```

A simple way to solve it, is to look for a common mutiple. I saw "150".

e.g. 75 is 2x 150s in parallel, 50 is 3 in parallel, & 25 is 6 in parallel, making a total of 11 150s in parallel = 150/11 = 13.636 QED.

Why don't U send an interesting bul?

73 de John G8MNY @ GB7CIP